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Analysis of Errors Made by 717 Collge Students in Arithmetic

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ANALYSIS OF ERRORS MADE BY 717 COLLEGE STUDENTS IN ARITHMETIC

BY

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CHAPTER I

HISTORICAL BACKGROUND FOR THE STUDY OF ERRORS IN ARITHMETIC

During the greater part of the elementary-school training of the average American child he receives a large amount of instruction and drill in arithmetic. In the high school he suddenly drops arithmetic except as he maintains practice in courses of science or high school mathematics and except as the transactions of every day life involve arithmetic. In college the individual may suddenly find that the amount of arithmetical knowledge required is not small as in physics, chemistry, or certain commercial courses. Evidence exists to indicate that students doing poor work in these courses are often found deficient in arithmetic.[1]

Pressey[2] found that the average freshman in college needed: (1) A knowledge of certain commonly appearing units of measure, (2) an understanding and use of the formula, and (3) skill in handling integers, decimals, and common fractions.

Courtis[3] reports that only thirty per cent of our pupils attain a per cent of accuracy above seventy.

1
H. J. Arnold, "Arithmetical Abilities and Disabilities of College Students," Elementary School Journal, Vol. 31, (December, 1930), pp. 259-70.

2
L. C. Pressey, "The Needs of Freshmen in the Field of Mathematics," School Science and Mathematics, Vol. 30, (March, 1930), pp. 238-45.

3.
J. C. Brown and L. D. Coffman, How to Teach Arithmetic (Chicago, Row, Peterson and Co., 1914), p. 38.

Coit[4] found many difficulties in high school algebra due to failure to understand simple arithmetic processes, but after a period of directed remedial drill he found marked improvement.

From a study in ninth grade algebra, Wattawa[5] found that 35 per cent of all errors were simple arithmetic errors.

Anspaugh[6] found in grades IV, V, and VI that 93 per cent of all errors in long division and in operations with common and decimal fractions were due to a lack of mastery of number facts rather than to a lack of understanding of the processes taught in these grades. After two years of a carefully planned method of teaching number facts, he found that "accuracy in common fractions had increased 70 per cent, in decimals 15 per cent, and in mixed fundamentals 40 per cent on the average in all grades where these operations were taught."

In an analysis of errors in common fractions, made by 470 students in the sixth and seventh grades, using the four fundamentals, Kee[7] lists the outstanding errors as follows: (1) failure to reduce, (2) substitution of one process for another, (3) confusion with the process itself, (4) general

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[4] F.A. Coit, "A Preliminary Study of Mathematical Difficulties," School Review, Vol. 34, (September, 1928), pp. 504-9.

[5] Virginia Wattawa, "A Study of Errors Made in a Ninth Year Algebra Class," Mathematics Teacher, Vol. 20, (April, 1927), pp. 212-22.

[6] G. H. Anspaugh, "Teaching the Number Facts in the Komensky School," A Co-operative Report of the Curriculum and of Supervision, (Chicago, Chicago Principals Club, 1927),pp.88-89.

[7] O. A. Kee, "Analysis of Errors in the Operation with the Common Fraction," American Education, Vol. 30, (May, 1927), pp. 2-5.

confusion of rules, and, (5) poor reduction, cancellation, or raising to higher terms.

Brueckner[8], in his analysis of errors in fractions concluded that errors in computation are the major difficulty in work with fractions. He states that the main difficulties in all processes are: (1) A lack of comprehension of the process involved, (2) difficulty in reducing fraction to lowest terms, and, (3) difficulty in changing improper fractions to whole numbers. He says, "The kind of errors analyzed exist in all grades studied and supplementary investigations show that they are found in large numbers in upper grades."

In an analysis of difficulties in decimals, Brueckner made the following conclusions:

1. Failure to place the decimal point correctly was the greatest cause of error.

2. Errors in addition due to inaccuracy were half as great as the number of errors due to the misplacing of the decimal point.

3. The major difficulty in subtraction was borrowing. This was three times as great as the difficulties peculiar to decimals.

4. Errors in multiplication due to inaccuracy were half as great as the number of errors involving the decimal point.

5. Major causes of errors in division of decimals were the misplacing of the decimal point, faulty placement of zeros, omission of the decimal point, and inaccuracy.

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[8] Leo J. Brueckner, "Analysis of Errors in Fractions," Elementary School Journal, Vol. 28, (June, 1928), pp. 760-70.

[9] _____, "Analysis of Errors in Decimals," Elementary School Journal, Vol. 29, (September, 1928), pp. 32-41.

Myers[10] thinks that 90 per cent of the trouble pupils have with the fundamentals is their failure to learn mechanically, without error, the basic facts in addition, subtraction, multiplication, and division.

Osburn[11] says we must teach the fundamental number facts so well that pupils will respond to them correctly even when they are thinking or reasoning about something else.

France[12] found that sixth, seventh, and eighth grade students have a lack of technical vocabulary. Their answers indicated they had heard of such statements as the average cost, average grade, and average weight, but they had no adequate concept of the term or exactly how to find the result desired. The same was true with area and other common terms.

Stevenson,[13] with the aid of thirty-two elementary teachers, made a study to determine why children have difficulty in solving arithmetic problems and found the following causes: (1) Physical defects (low mentality included here), (2) lack of skill in the fundamentals, (3) inability to read, (4) lack of general technical vocabulary, and, (5) lack of proper methods of technique of attacking problems.

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10 G. C. Myers, "Hard Subtraction," Grade Teacher, Vol. 52, (December, 1934), p. 41.

11 W. J. Osburn, Corrective Arithmetic (Boston, Houghton Mifflin Co., 1924), p. 122.

12 O. C. France and P. V. Stevenson, "Remedial Instruction in Arithmetic," Educational Research Bulletin, Vol. 2, (November, 1933), pp. 291-97.

13 P. V. Stevenson, "Difficulties in Problem Solving," Journal of Educational Research, Vol. 2, (February, 1925), pp. 95-103.

The purpose of this study is to make an analysis of errors made on an achievement test in arithmetic by college students of Western Kentucky State Teachers College, showing the frequency and as far as possible the cause of each error. These students were preparing to become teachers and many of them had already taught. In reality this analysis of errors is a practical extension and checking application of what has already been done in the field, determining if these students are typical of other groups, and letting the results form the basis for remedial instruction and effective teaching. The findings of this study should be of interest: (1) To grade teachers as a foundation for planning their work in arithmetic and as a basis for remedial work with poor students, and (2) to teacher training institutions in the training of teachers. The end to which schools should strive is prevention rather than remedy. Many difficulties should be eliminated by means of teacher's explanation, more favorable distribution of grade placement of certain topics, and more detailed analysis of mental processes of pupils as they are working.

The specific purpose of this study may be stated as follows: To determine the status of achievement in arithmetic of 717 college students preparing to become teachers, with special emphasis on errors, and as far as possible to decide the cause of such errors.

CHAPTER II

SET UP OF THE STUDY

The data of this study were obtained from 717 arithmetic tests given preparatory teachers, of Western Kentucky State Teachers College, on entering Education 110, during the second semester 1933. Education 110, Teaching the Common School Branches, is a course devoted to a study of the common school branches as outlined in the State Course of Study, with special reference to the problems met in the teaching of these subjects. The test used was the new Stanford Achievement Test, Form Z.[1] The purpose of giving this test was to give the students some practice in interpreting tests, and also, to give the instructors some notion as to what was lacking in the mastery of the subject with the idea of bringing these prospective teachers to a higher standard.

The papers were checked. The arithmetic age computed, and from the arithmetic age was computed the median. As to the amount of arithmetic previously studied, there were the following groups: (1) Those having had neither high school nor college arithmetic, (2) those having had college but not high school arithmetic, (3) those having had high school but not college arithmetic, and, (4) those having had both high school and college arithmetic. The median was computed for each of these groups.

Score 100 and below was the point on the scale below which

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[1] See appendix page 38.

the grades were considered as unsatisfactory. A score of 100 is the norm for ninth grade arithmetic on this particular test. Since usually no arithmetic is taken after this grade, the defects already present are not likely to be corrected. A total of 128 persons or 18 per cent of the total group of 717 students in the study, were found to be in this group. Throughout the study they are known as the Low Group. The 589 students with scores above 100 are referred to as the High Group. The two groups are studied comparatively and combined into a total group for the final analysis.

Special Studies Made for the Low Group

Using the reports in the office of the registrar, a study of the grade point average was made to determine the standing of each of the 128 students in other subjects. The purpose of this was to discover if the student ranked low in all of his work or if he was deficient in arithmetic only. Using these same records, another study was made for this group, of the grades made by them when they took College Teacher's Arithmetic. These grades tell the difficulty of this subject for these students.

Since psychological tests are usually accepted as indicative measurements of ability, a study of percentile ranking was made from the records of the psychological tests taken by these students of the Low Group when they entered college.

Studies Made for the Total Group

From the tabulation of the total number of errors per problem, a comparative study of errors in reasoning and in computation was made and the topics were ranked according to averaged difficulty. From the tabulation of the total number of errors per problem, the problems were ranked according to difficulty for both reasoning and computation. For all problems in which 25 per cent or more of the students of the Total Group made errors, a detailed analysis of errors was made. As nearly as possible the cause for each error was determined. This analysis of errors was made for both the Low and High Groups for the purpose of comparison and combined for a final study of the Total Group. The 25 per cent of errors was chosen as the point at which group remedial work should be given, on the assumption that when one person out of four makes errors it becomes a group rather than an individual problem.

In order to show that the group studied is typical, a comparative study was made of the total per cent of errors made by another group of 425 prospective teachers of Western Kentucky State Teachers College. The same arithmetic test was used for these students upon entering the Education 110 classes, during the second semester of 1935.

CHAPTER III

ANALYSIS OF ERRORS MADE BY 717 COLLEGE STUDENTS IN ARITHMETIC

In basing suggestions for the improvement of instruction upon errors, it is assumed that success frequently results from the study of failures. Industrial concerns find it profitable to study situations in which their output falls short of the expected amount. Although few salesmen talk about the weak points of what they sell, it is safe to assume that good salesmen have a pretty definite knowledge of what these weak points are. Teachers, however, have almost always been destitute of such information. A teacher goes out to work in rural or urban schools should be fairly well grounded in the fundamental subjects in order that she may teach effectively the required course of study. Teachers should see to it that our schools are kept abreast with the progress of science and industry.

There are difficulties in arithmetic consisting of fundamental concepts and skills that should be isolated and mastery attempted. Methods of mastery must be found if we are to teach our pupils when to apply these concepts and skills. It is believed that much of the remedial work can be eliminated by effective teaching that is based upon scientific investigation.

In studying the range of scores made on the achievement test in this particular study, and in determining the effect the amount of arithmetic studied above eighth grade had upon the achievement of college students, an arithmetic grade distribution was made.

TABLE I

DISTRIBUTION OF 717 STUDENTS ON ARITHMETIC TEST, SHOWING ARITHMETIC GRADE, AMOUNT OF ARITHMETIC STUDIED ABOVE THE EIGHTH GRADE, MEDIAN FOR EACH GROUP, AND TOTALS

Arithmetic Grade	Number having had arithmetic in: High School or College				Totals
	Neither	College	H. S.	Both	
Tenth grade or above	43	133	71	342	589[a]
Ninth grade	13	18	4	19	54
Eighth grade	1	11	5	17	34
Seventh grade	2	4	1	10	17
Sixth grade	1	7	5	8	21
Fifth grade	0	1	1	0	2
Total in Low group	17	41	16	54[b]	128[c]
Total in both groups	60	174	87	396	717
Per cent of Total group	8%	24%	12%	56%	100%
Median on test	103.5	104.7	106.1	106.4	105.7

Table I shows the grade distribution for the entire group of 717 students, ranging from the tenth grade or above, down through the fifth grade. The arithmetic grade is the one that is derived from the norm of the test. A grade distribution showing the amount of arithmetic previously studied is shown for each

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[a] High Group

[b] One half of Low Group are in the eighth grade or below

[c] The Low Group is 18 per cent of the Total Group

person. The median is computed for each of the following groups: (1) Those that have had neither high school nor college arithmetic, (2) those having had college but not high school arithmetic, (3) those having had high school but not college arithmetic, and, (4) those having had both high school and college arithmetic. Column five gives the totals.

A comparative study of medians and grade distribution for the various groups fails to show any consistent improvement or special advantage of one group over another. The indications are that neither high school nor college arithmetic, so far as this test is a criterion, does much in preventing the type of errors made on this test.

Studies for the Low Group

TABLE II

PERCENTAGES OF LOW GROUP FALLING IN EACH ARITHMETIC GRADE AND AVERAGE GRADE POINT

	Fifth grade	Sixth Grade	Seventh grade	Eighth grade	Ninth grade
Per cent of Low Group	1%	16%	20%	23%	40%
Averaged Grade Point	.80	.87	.91	1.05	1.2

It will be recalled that the Low Group included the 128 persons with the ninth grade classification, or below, according to the norm of the test used. The percentage of the Low Group falling in the fifth, sixth, seventh, eighth, or ninth grades

and the grade point average for each grade is given in Table II. It shows (1) that 37 per cent of the Low group are in the seventh grade or below, and that the grade average for the group is less than 1, (2) that 23 per cent are in the eighth grade with an averaged grade point of 1.05, and, (3) that 40 per cent are in the ninth grade with a grade point of 1.2. Students must have a grade point average of 1 or more before they are eligible to graduate. These data indicate that students making a rating of fifth, sixth, seventh, or eighth grade on this test do not rank high in college subjects.

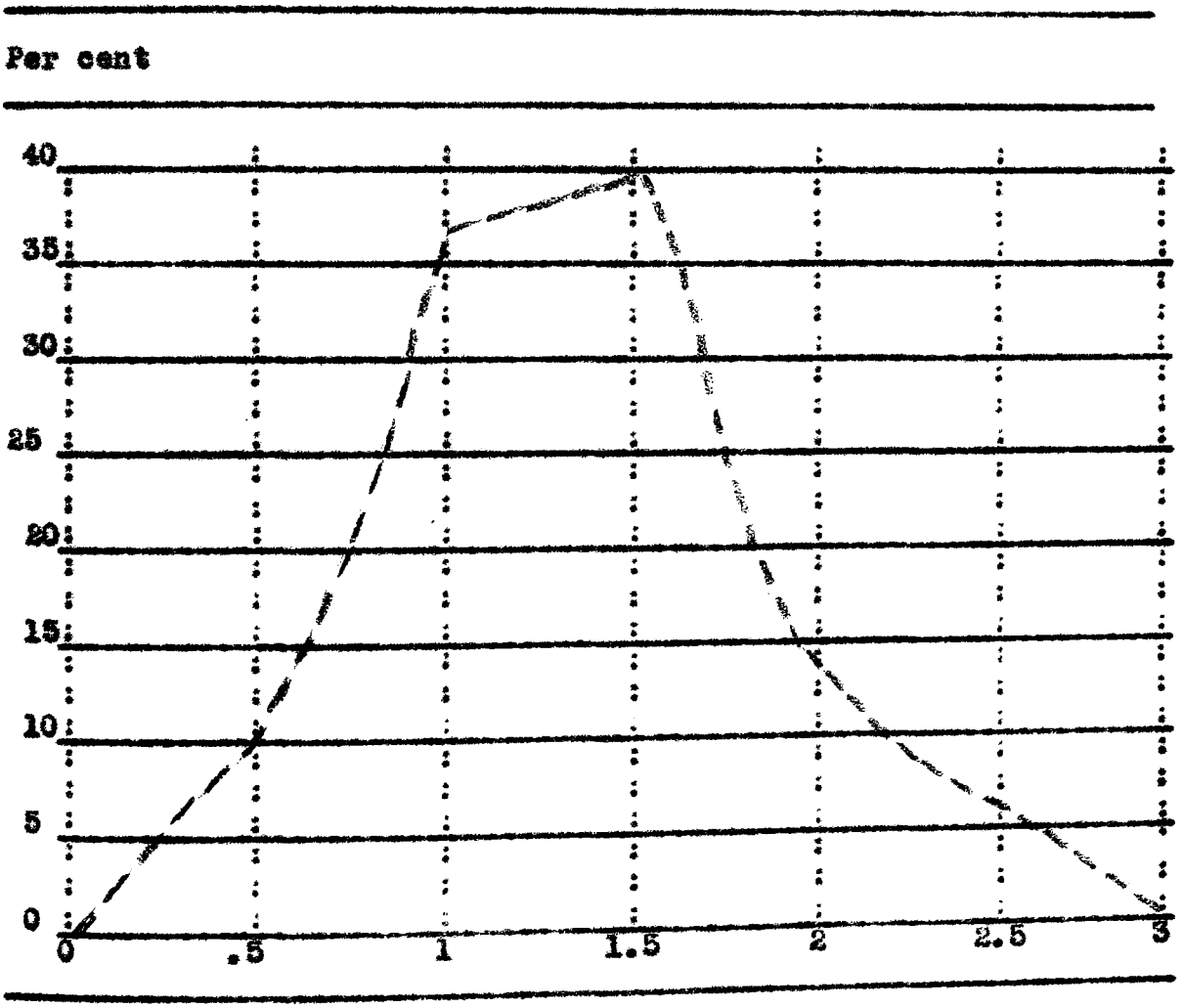

DIAGRAM I. GRADE POINT DISTRIBUTION FOR LOW GROUP IN PERCENTAGES

The grade point distribution for the Low Group is shown in percentages in Diagram 1. It shows that 10 per cent of the Low Group have a grade point average of less than .5; that 37 per cent have more than .5, but less than 1. Thus 47 per cent of the Low Group have an unsatisfactory grade point average of less than 1. It also shows that 40 per cent of the group had a standing of 1, and 14 per cent of the entire Low Group had a grade point average of 1.5 or above.

Of the Low Group 92 per cent had been on probation one or more times, and the standing of 1 was attained in most cases only after many repetitions of courses.

Since psychological tests are accepted as indicative measurements of ability, a study of percentile ranking was made from the records of the Low Group when they entered college.

TABLE III

PERCENTILE RANKING OF 128 STUDENTS OF THE LOW GROUP ON PSYCHOLOGICAL TESTS WITH PER CENTS

Percentile rank	Per cent of group studied	Remarks
55	6%	8% in upper half of percentile rank
50	7%	
45	5%	35 % of group were in second quartile
40	7%	
35	3%	
30	10%	
25	14%	
20	16%	57% of the Low Group were in the first, or lowest, quartile
15	7%	
10	7%	
5	13%	

The percentile rank means the standing a student received on the psychological test when taken. For example, percentile 55 means that 45 per cent of those taking the test stood above those of this rank, and percentile 5 shows that 95 per cent of those taking the test stood above those with the percentile rank of 5. Table III shows that only 8 per cent of the Low Group were in the upper half of the percentile ranking at the time they took the psychological test, and that 57 per cent of the group were in the first quartile, or the lowest 25 per cent. This indicates rather high correlation between psychological tests and arithmetic test.

Comparing this study of percentiles and the arithmetic grade rating made on the arithmetic test, one may conclude that remedial work of some sort is needed to bring these students to a higher standard of achievement in arithmetic.

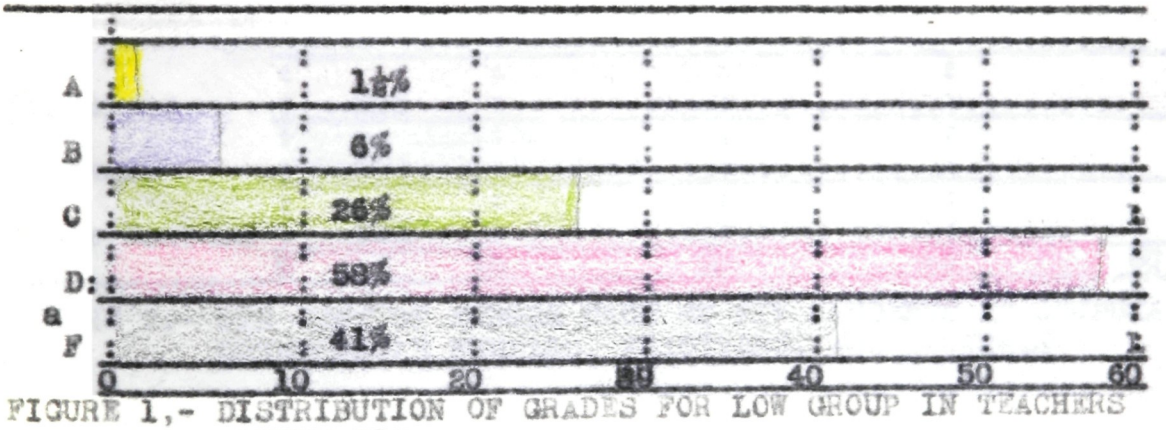

FIGURE 1,- DISTRIBUTION OF GRADES FOR LOW GROUP IN TEACHERS ARITHMETIC

[a] The per cents in this study total more than 100 because so many students repeated the course.

A study of grades made by those students taking the college course of Teachers Arithmetic is shown in Figure 1. It is significant that 58 per cent of the Low Group having had this course passed it with the grade of D. This shows that more than half of the low group passed the course with a very poor grade and many of them had repeated the course one or more times before passing with this unsatisfactory grade. Information for grades A, B, C, D, and F is shown in the diagram.

A further analysis of the data showed that one third of those passing with the grade of C had failed at least once before securing a passing grade, and that 40 per cent of those passing with the grade of D had failed one or more times before passing. Those making the grade of F repeated the course from one to four times and some did not pass at all.

Studies for the Total Group

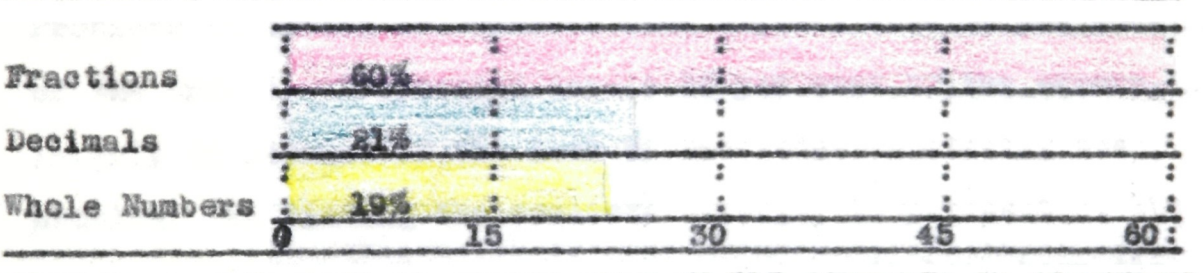

FIGURE 2.- PER CENT OF ERRORS MADE BY 717 STUDENTS IN COMPUTATION USING WHOLE NUMBERS, FRACTIONS, AND DECIMALS

From a study of those problems involving addition, subtraction, multiplication, and division, Figure 2 gives the per cent of computational errors made by the Total Group in mixed fundamentals in fractions, decimals, and whole numbers.

It will be noted that 60 per cent of these errors in computation are in fractions. Indications are that special emphasis should be given fractions using more effective methods in order that the fundamental principles involved will carry over for use in later life.

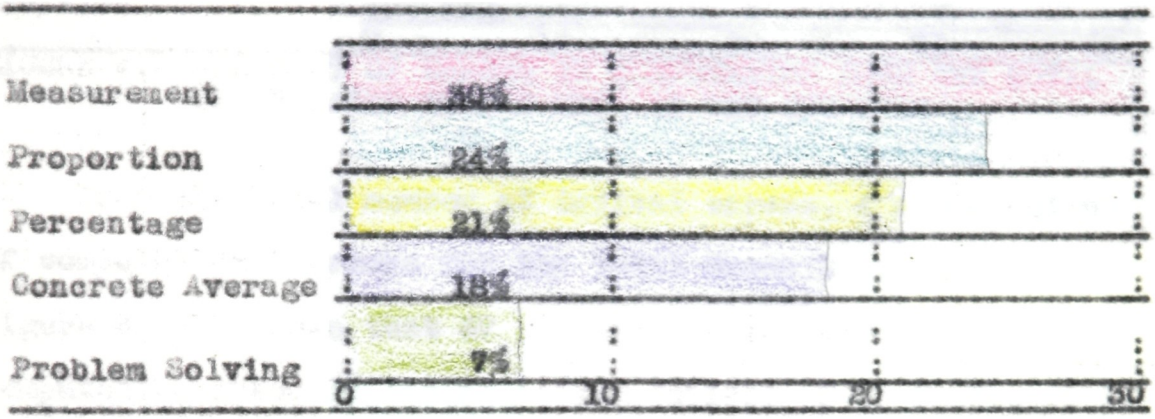

FIGURE 3.- PER CENT OF ERRORS IN REASONING FROM THE TOTAL OF AVERAGED ERRORS MADE BY 717 STUDENTS

The problems were classified and the average number of errors for each topic in Reasoning is given in Figure 3. Problems involving measurement rank highest with 30 per cent of the errors. Proportion totals 24 per cent of the errors, largely on account of the lack of knowledge in stating the problem. In finding the concrete average, 18 per cent of the errors occurred, and the major cause seemed to have been the lack of understanding the word average and the knowledge of how to find it. The concrete average, as referred to here, is dealing with finding the average of concrete numbers and the abstract average referred to in Table V is finding the average of abstract numbers.

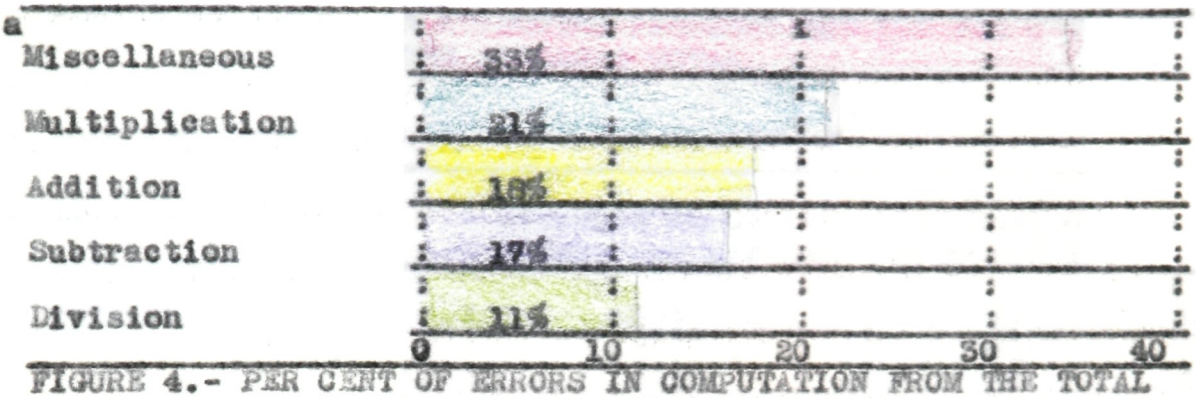

FIGURE 4.- PER CENT OF ERRORS IN COMPUTATION FROM THE TOTAL OF AVERAGED ERRORS MADE BY 717 STUDENTS

From the total number of topical errors, a distribution of computational errors for the Total Group is given in Figure 4. It shows that 67 per cent of the errors in Computation occur in the following topics: Four fundamentals in mixed numbers, fractions, compound denominate numbers, and decimals.

The averaged number of topical errors per problem made by 717 students and the per cent that topic is of averaged total is given for Reasoning in Table IV on the following page.

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[a] Those problems included in the Miscellaneous Group are: Abstract average, graphs, square root, algebra, pictorial area, percentage, and raising a number to a higher power.

TABLE IV

NUMBER OF ERRORS IN REASONING PROBLEMS AND THE PER CENT OF THE AVERAGED TOTAL

Topic	Averaged number of errors per problem	Per cent of the averaged total
Percentage	305	24
Problem Solving	267	21
Measurement	252	20
Proportion	245	20
Concrete Average	181	15

There were on the average 305 errors per problem in Percentage and this equals 24 per cent of the averaged total of errors. This information is given for each of the topics.

TABLE V

NUMBER OF ERRORS IN COMPUTATION PROBLEMS AND PER CENT OF TOTAL ERRORS

Topic	Averaged number of errors per problem	Per cent of the averaged total
Abstract Average	393	17
Graphs	291	12
Square Root	240	10
Algebra	236	10
Pictorial area	203	9
Raising number to higher power	181	8
Percentage	181	8
Multiplication	177	8
Division	154	7
Subtraction	121	5.5
Addition	120	5.5

Table V shows the averaged number of errors per problem

by topics and the per cent of errors per problem of the averaged total of errors in Computation. A study of this table reveals the fact that those problems listed under miscellaneous in Figure 4, including 33 per cent of the errors in the averaged totals, ranked highest in difficulty per problem. The abstract average was missed by 55 per cent of the 717 students in this study. If finding the average, reading graphs, extracting the square root, and the like are essentials in the child's knowledge of arithmetic, then certainly we should expect these topics to be taught in such a manner that they will carry over for use in later life, and, seemingly, this should not be extremely difficult to do.

TABLE VI
PROBLEMS IN REASONING ON WHICH 25 PER CENT OR MORE OF THE 717 STUDENTS OF THE TOTAL GROUP MADE ERRORS

Rank	Problem number	Per cent of errors	Number of errors	Number omitted	Topic
1:	40	85	607	442	Percentage
2:	26	46	330	65	Proportion
3:	30	44	316	169	Measurement
4:	25	41	293	18	Percentage
5:	36	39	282	95	Problem Solving
6:	27	37	264	139	Percentage
7:	32	36	261	52	Percentage
8:	21	35	252	18	Problem Solving
9:	24	35	252	50	Measurement
10:	34	34	242	72	Proportion
11:	35	32	232	78	Proportion
12:	29	29	209	44	Percentage
13:	33	27	192	91	Percentage
14:	31	26	188	55	Measurement
15:	28	25	181	67	Concrete Average

[a] The low rank assigned this problem was due to so many omitting it. Many of those attempting to solve it confused the process; just how much the time element entered into the large number of omissions one cannot say.

The problems in Reasoning in which 25 per cent or more of the Total Group made errors are ranked by difficulty in Table VI. The number of errors are shown for each problem. Problems that were omitted were included with those wrong. It is assumed that when a large per cent of the group omitted a problem that there was some difficulty that caused the hesitancy in attempting to solve it. The range in omission was from 18 to 442. Column five gives the number omitted for each of the problems in this study.

From a study of the detailed analysis of errors, it was found that the major causes of errors for the Low and High Groups were approximately the same. The causes of errors are listed as follows:

1. Misinterpretation of the problem, probably caused mainly by verbal difficulties in reading problems.

2. Lack of complete analysis of problem.

3. Use of wrong processes.

4. Disregard of a fact to be supplied. For example, a year has twelve months.

5. Use of numbers not directly related. Failure to grasp the relation of various data in the problem and attempt to solve the problem by using together numbers which were only related indirectly.

6. Confusion in method. Used method which indicated that they had no clear idea of the relation of the data given in the problem.

7. Failure to appreciate the impossibility of an absurd

answer.

8. Lack of knowledge in stating problems in proportion.

9. Difficulty with the decimal point.

10. Difficulty with the vocabulary. Did not apply the meaning of certain words in solving the problems.

11. Computational errors were common to all problems.

TABLE VII

PROBLEMS IN COMPUTATION ON WHICH 25 PER CENT OR MORE OF THE 717 STUDENTS MADE ERRORS

Rank	Problem number	Per cent of errors	Number of errors	Number omitted	Topic
1	51	55	393	41	Abstract Average
2	60	54	385	223	Algebra
3	50	48	344	304	Graphs
4	47	47	338	46	Multiplication of Decimals
5.	48	41	294	38	Subtraction of mixed numbers
6	57	41	293	202	Algebra
7	43	38	269	50	Division of Decimals
8	25	35	251	9	Multiplication of Whole Numbers
9	52	35	251	131	Division of Fractions
10	58	33	236	153	Extracting the Square Root
11	53	32	232	66	Multiplication of Comp. Denominate No.
12	40	32	227	22	Multiplication of Whole Numbers
13	46	31	223	44	Addition of Fractions
14	38	30	216	23	Multiplication of Decimals
15	55	28	203	138	Pictorial Area
16	49	28	202	176	Graphs
17	32	26	189	20	Subtraction of Mixed Numbers
18	34	26	188	21	Addition of Mixed Numbers
19	45	25	181	95	Percentage-Discount
20	54	25	191	66	Raising number to Higher Power

The problems in Computation in which 25 per cent or more of the students of the Total Group made errors are ranked by difficulty in Table VII on the preceding page. The number of errors are shown for each problem. Problems that were omitted were included with those wrong. It is assumed, as in Reasoning problems, that when a large per cent of the group omit a problem that there is some difficulty causing the hesitancy in attempting to solve it. The range in omission was from 9 in multiplication of whole numbers to 304 in graphs. Column five gives this information for each of the problems included in this study.

Comparative Study for the Low and High Groups with a Summary of Errors and some Conclusions

A detailed analysis of computational errors is shown in Table VIII on pages 24 to 27. Errors are shown in per cents for the Total, Low, and High Groups for comparison. In reading this table we find in the addition of fractions that 62 per cent of the errors made by 717 students of the Total Group were caused by failure to reduce the fraction, that 47 per cent of the errors made by the 128 students in the Low Group, and that 70 per cent of the errors made by the 589 in the High Group were caused for this same reason in this particular topic. A reading of the table gives similar information for the three groups under the topics listed.

TABLE VIII

DETAILED ANALYSIS OF ERRORS IN COMPUTATION MADE BY THE TOTAL, LOW, AND HIGH GROUPS

	Total Group	Low Group	High Group
I ADDITION			
A Fractions			
1. Failure to reduce fraction	62%	47%	70%
2. Failure to carry in addition	16%	15%	18%
3. Error in reducing to G. C. D.	8%	14%	5%
4. Reduced to impossible C. D.	6%	8%	4%
5. Added numerators without reducing to Common Denominator	3%	5%	1%
6. Error in reducing fraction Ex. 47/24 are 1 3/24	3%	4%	2%
7. Failure to finish problem	2%	7%	0%
Totals	100%	100%	100%
B Mixed Numbers			
1. Failure to add whole number from fraction			
2. Failure to reduce fraction	15%	15%	15%
3. Error in adding fraction	11%	8%	13%
4. Ignored fraction	9%	15%	5%
5. Error in reducing fraction	8%	12%	5%
6. Subtracted minuend from subtrahend in fraction	6%	6%	7%
7. Added whole number but subtracted fraction	4%	3%	5%
8. Subtracted instead of adding	3%	0%	5%
9. Carried in addition when nothing to carry	1%	2%	0%
Totals	100%	100%	100%
II SUBTRACTION			
A Mixed Numbers			
1. Failure to reduce fraction	33%	36%	32%
2. Error in borrowing	24%	25%	24%
3. Added instead of subtracting	9%	9%	9%
4. Ignored fraction	10%	8%	9%
5. Miscellaneous errors in subtracting fraction	24%	22%	26%
Totals	100%	100%	100%

	Total Group	Low Group	High Group
III MULTIPLICATION			
A Whole Numbers			
1. Error in multiplication combination	64%	58%	67%
2. Failed to carry in addition	8%	11%	7%
3. Carried in addition - should not	8%	9%	8%
4. Error in addition combination	7%	3%	10%
5. Failure to carry in multiplication	6%	9%	4%
6. Failure to multiply by all numbers	6%	8%	3%
7. Confused number in carrying. Ex. carried 5 and put down 5 in answer	1%	2%	0%
Totals	100%	100%	100%
B Decimals			
1. Error in multiplication combination	42%	35%	45%
2. Decimal in wrong place	15%	14%	16%
3. Error in addition combination	10%	7%	12%
4. Ignored decimal	9%	13%	8%
5. Failed to carry in addition	8%	9%	7%
6. Failed to carry in multiplication	6%	10%	4%
7. Carried in addition- should not	6%	7%	5%
8. Failure to multiply by all numbers	3%	3%	3%
9. Added instead of multiplying	1%	2%	1%
Totals	100%	100%	100%
C Compound Denominate Numbers			
1. Multiplied, failed to reduce	87%	90%	86%
2. Error in reducing	4%	0%	6%
3. Reduced all to inches and multiplied total by four	4%	6%	3%
4. Reduced inches to feet but not feet to yards	3%	4%	2%
5. Error in multiplication	2%	0%	3%
Totals	100%	100%	100%
IV DIVISION			
A Decimals			
1. Confusion in placing the decimal point	53%	57%	51%
2. Failed to draw down zero in answer	28%	24%	31%
3. Failed to draw down zero in product	10%	10%	10%
4. Error in divisor	9%	9%	8%
Totals	100%	100%	100%

ANALYSIS OF ERRORS (CONTINUED)

	Total Group	Low Group	High Group
IV DIVISION (CONTINUED)			
B. Fractions			
1. Failed to reduce fraction	70%	64%	73%
2. Inverted wrong number	13%	23%	9%
3. Inverted both numbers	5%	0%	6%
4. Added fraction instead of dividing	4%	4%	4%
5. Did not finish problem	4%	4%	4%
6. Multiplied without inverting	1%	1%	1%
7. Miscellaneous errors	4%	4%	4%
Totals	100%	100%	100%
V MISCELLANEOUS			
A Percentage -- Discount			
1. Found discount, failed to find selling price. A few omitted decimal point and results were $5000 instead of $50.00	43%	47%	41%
2. Added discount to marked price to get selling price	35%	13%	48%
3. Miscellaneous errors	22%	40%	11%
Totals	100%	100%	100%
B Graphs			
1. Few miscellaneous errors			
2. Several wrote "Never studied graphs"			
3. Usually omitted			
C Abstract Average			
1. Failed to draw down zero in answer (4.74 instead of 4.074)	30%	10%	40%
2. Added but did not divide to find the average	25%	33%	20%
3. Error in placing the decimal point	15%	24%	10%
4. Error in division	14%	17%	13%
5. Error in addition	12%	16%	11%
6. Miscellaneous errors	5%	0%	6%
Totals	100%	100%	100%

ANALYSIS OF ERRORS (CONTINUED)

	Total Group	Low Group	High Group
V MISCELLANEOUS (CONTINUED)			
D Raising Number to Higher Power			
1. Raised to fifth power instead of fourth	33%	25%	38%
2. Said 4x5 equals 20 instead of raising to higher power	30%	50%	16%
3. Said 725 instead of 625	27%	18%	33%
4. Raised number to 6th, 7th, 8th, or ninth power	8%	7%	10%
5. Miscellaneous	2%	0%	3%
Totals	100%	100%	100%
E Pictorial Area			
1. Found total area and failed to finish problem	60%	66%	54%
2. Found area for portion not asked for	17%	22%	12%
3. Miscellaneous errors	23%	12%	34%
Totals	100%	100%	100%
F Square root			
1. Found first square, did not finish	42%	41%	43%
2. Pointed off from left to right	38%	56%	30%
3. Found largest square and used it as complete divisor	17%	3%	23%
4. Impossible answer	3%	0%	4%
Totals	100%	100%	100%
G Algebra			
1. Errors seemed to be due to not understanding the process and there was much confusion in adding minus quantities.			

A careful study of the errors made by the Low and High Groups reveals the fact that in the main the chief sources and types of errors were strikingly similar and appear to agree closely.

The chief difficulty in addition and subtraction of fractions was the finding of the common denominator and reducing to lowest terms. In division of fractions, the chief errors were the failure to invert the divisor and incorrect reduction to lowest term.

It may seem somewhat startling to find that a considerable number of college students were apparently unable to deal accurately with simple operations of addition, multiplication, subtraction, and division of whole numbers. However, the difficulty in each case appears to center around specific operations, for example, carrying, borrowing, or making computations.

Computational errors are one of the major difficulties for both the Low and the High Groups. A considerable portion of the actual errors seemed to have been the result of careless reading. Since the Stanford Achievement test is of a mixed fundamental type and the directions for the separate examples are in some cases given in words and in other instances given by the sign or symbol for the operations, careless pupils frequently solved problems by some operation other than the one specified on the printed sheet. Such errors may have arisen from carelessness, unfamiliarity with the vocabulary or symbols of arithmetic, perseverations of mental set from the preceding

example, and the like.

The problems in decimals included all types of errors common to addition, subtraction, multiplication, and division. Other common errors were (1) The incorrect placing of the decimal point, (2) disregarding the decimal point entirely, and, (3) faulty placement of zeros and failure to prefix or annex them when needed.

In denominate numbers the most common errors were failure to reduce to the usual form and mistakes indicating inability to reduce units of one denomination to another.

In the miscellaneous operations and in problem solving the errors were as follows: (1) Failure to follow directions which were apparently understood, (2) securing incomplete answers, (3) use of wrong process, (4) lack of complete analysis of problem, (5) lack of comprehension of process, (6) incorrect computations, (7) errors common to the decimal point, and, (8) misinterpretation of the problem, probably caused mainly by difficulties in reading verbal problems.

In teaching problem solving students should be taught to have a technique or method to follow. They should know that sufficient data are given to determine the desired information. They should be taught to read problems carefully, giving special attention to technical vocabulary. After reading the problem one may ask himself (1) What am I asked to find, (2) what is given to help me do this, and, (3) what process or processes must I use?

From a careful study of the types and causes of errors

found in this study and in investigations previously made, it seems safe to predict a reasonable amount of accuracy and skill by most students in solving problems in arithmetic when adequate preventive teaching is used and then followed up by carefully planned remedial work when needed.

Comparisons of 717 College Students with a Similar Group of 425 Students in Results Made on an Achievement Test in Arithmetic

In order to show that the group studied is typical, a comparative study was made of the total per cent of errors made by another group of 425 prospective teachers of Western Kentucky State Teachers College. The same test was used for these students entering the Education 110 classes, during the second semester of 1935. It will be recalled that the 717 students in this study took the New Stanford Arithmetic Test in the Education 110 classes, during the second semester of 1933. This group of 717 students that have been studied will be designated as group A, and the group of 425 which were compared with them will be designated as group B.

In a comparison dealing with the per cent of errors in fractions, whole numbers, and decimals using the mixed fundamentals, it was found that the two groups were very similar, fractions having the common rank of 60 per cent of errors .

In comparing groups A and B, it was found that all problems were common to both groups on which 20 per cent or more students made errors, and in both Reasoning and Computation 50 per cent of the problems on the test were found to have 20 per cent or

more errors per problem. On the whole there were no marked differences in the rank of the two groups.

In ranking the averaged errors per problem by topics, it was found that 67 per cent of the errors in Group A were made while dealing with the four fundamentals in whole numbers, mixed numbers, fractions, and decimals, and that Group B had 68 per cent in this class.

Reasoning and Computation were of approximately equal difficulty in Group A, but Reasoning ranked slightly higher in Group B.

No comparison is made of the two groups in the detailed analysis of errors, but in all comparisons that were made the findings were quite similar.

Groups A and B when combined total 1142 students and the findings combined group points toward special emphasis on the four fundamentals in all processes and the indications are that a great deal more emphasis and perhaps more time should be spent in learning or overlearning the principles dealing with fractions.

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary of Findings for 128 College Students in Low Group

1. Students making a rating of fifth, sixth, seventh, or eighth grade on the arithmetic test ranked low in college subjects, the grade-point average of one being attained usually only after many repetitions of courses.

2. A comparison of the percentile rank made on the psychological tests and the arithmetic grade rating made on the arithmetic test of 128 college students of the Low Group, indicates a rather high correlation between psychological tests and the arithmetic grade rating made on the test, which may be the logical thing to expect since psychological tests usually involve more or less arithmetic.

3. Of the Low Group 57 per cent were in the first or lowest quartile ranking at the time they took the psychological test and only 8 per cent were in the upper half of the percentile ranking.

4. Students of the Low Group made very low grades in the college course of Teachers Arithmetic.

Summary of Findings for 717 College Students in the Total Group

1. A comparative study of the medians and grade distribution for 717 College Students, in determining the effect of the amount of arithmetic studied above eighth grade had upon the achievement in arithmetic, indicates that neither high school

nor college arithmetic, so far as this test is a criterion, do much in preventing the type of errors made on this test.

2. A distribution of errors dealing with whole numbers, fractions, and decimals shows that 60 per cent of these errors occur in fractions.

3. Of the total number of errors in computation, 67 per cent occurred in the four fundamentals in mixed numbers, fractions, compound denominate numbers, and decimals, and 33 per cent occurred in the miscellaneous group of problems including the following: (1) abstract average, (2) reading graphs, (3) algebra, (4) square root, (5) pictorial area, (6) percentage, and, (7) raising a number to a higher power.

4. Reasoning problems when ranked according to difficulty are as follows: (1) Percentage, (2) problem solving, (3) measurement, (4) proportion, and, (5) concrete average.

5. Computational problems when ranked according to difficulty are as follows: (1) Abstract average, (2) reading graphs, (3) square root, (4) algebra, (5) pictorial area, (6) raising a number to a higher power, (7) percentage, (8)multiplication, (9) division, (10) subtraction, and, (11) addition.

6. In Reasoning and Computation the major causes and types of errors were approximately the same for the Low and High Groups.

The major types of errors in Reasoning are as follows: (1)Misinterpretation of problem, (2) lack of complete analysis of problem, (3) use of wrong process, (4) disregard of a fact to be supplied, (5) use of numbers not directly related, (6)

confusion in method, (7) failure to appreciate the impossibility of an impossible answer, (8) difficulty with vocabulary, (9) lack of knowledge in stating problems in proportion, (10) difficulties with the decimal point, and (11) computational errors were common to all problems.

(8) The major causes of errors in Computation are as follows: (1) Whole Numbers: (a) Carrying, (b) borrowing, (c) computations in simple operations, and, (d) use of wrong process.

(2) Fractions and Whole Numbers: (a) Mistakes in reducing fractions to common denominator before adding or subtracting, (b) failure to invert the divisor in division, (c) incorrect reduction of fractional answer to lowest terms, (4) failure to reduce fraction to lowest terms, and, (e) failure to change improper fraction to mixed number.

(3) Compound Denominate Numbers: (a) Failure to reduce to the usual form, and, (b) mistakes indicating inability to reduce units of one denomination to another.

(4) Decimals: (a) Failure to place decimal point correctly, (b) complete omission of decimal point, (c) faulty placement of zeros, and failure to prefix and annex zeros when needed, and,(d) inaccuracy in adding, subtracting, multiplying and dividing.

(5) Miscellaneous Problems: These included the abstract average, graphs, raising a number to a higher power, pictorial area, square root, percentage, and algebra. The major causes for errors were: (a) Failure to follow directions

apparently understood, (b) securing incomplete answer, (c) use of wrong process, (d) lack of skill in using fundamentals, (e) lack of general technical vocabulary, and, (f) unfamiliarity with processes.

(9) In comparing the Total Group of 717 college students of this study with a like group of 425 college students, it was found that the two groups were very similar in all comparisons that were made.

Conclusions

Two of the most important tasks in teaching arithmetic are increasing the skill with which pupils use the fundamentals and increasing their knowledge of when to use them. The first deals with <u>how</u> and the second with <u>when</u>.

A considerable number of college students are apparently unable to deal accurately with simple operations of addition, subtraction, multiplication, and division, for example, carrying numbers, borrowing, and making simple computations. Computational errors are one of the major difficulties, and a considerable portion of the actual errors seemed to be the result of careless reading. Since the Stanford Achievement Arithmetic Test is of a mixed fundamental type and the directions for the separate examples are in some cases given in words and in other instances given by signs for the operations, some pupils frequently solved problems by an operation other than the one specified on the printed sheet. Such errors may have arisen from carelessness, perseverations

of mental set from the preceding example, and the like.

There should be a more favorable distribution of time devoted to the various topics. More time should be allotted to the four fundamentals in whole numbers, mixed numbers, fractions, decimals, and compound denominate numbers, with special emphasis on fractions. If reading graphs, extracting the square root, etc., are essential parts of the child's knowledge in arithmetic, then certainly we should expect them to be taught in such a manner that they will be retained for use in later life.

Recommendations

It is recommended that scientific experimentation in effective teaching and remedial work be done in arithmetic. Supervised studies should be made dealing with (1) children in the grades using standards and methods that have been carefully planned for effective teaching, and continuing the investigation with scientific supervision in remedial work for those needing it, and (2) that some sort of supervised remedial instruction in the form of individual units be built and given college students making a rating of eighth grade or below on the arithmetic test. It is further recommended that studies be made of the detailed analysis of mental processes of pupils as they are working to determine individual difficulties in solving problems. Special attnetion should be given to teaching pupils to read problems and to develop a technique for working them, emphasizing the vocabulary used in problems,

especially technical words, trying at all times to increase the skill with which they use the fundamentals and their knowledge of when to use them.

New Stanford Arithmetic Test

By TRUMAN L. KELLEY, GILES M. RUCH, and LEWIS M. TERMAN

TEST: FORM Z

FOR GRADES 2-9

Name..... Grade..... Boy or girl.....

Age..... When is your next birthday?..... How old will you be then?.....

Name of school..... Date.....

Score	Arith. Age	School[1] Grade	Score	Arith. Age	School[1] Grade	Score	Arith. Age	School[1] Grade	Score	Arith. Age	School[1] Grade	Score	Arith. Age	School[1] Grade
120	19–2		100	15–8	9.7	80	12–6	6.7	60	10–8	4.7	40	9–3	3.4
119	18–11		99	15–6	9.5	79	12–4	6.6	59	10–7	4.6	39	9–2	3.4
118	18–8		98	15–4	9.3	78	12–3	6.4	58	10–6	4.6	38	9–1	3.3
117	18–5		97	15–2	9.2	77	12–2	6.3	57	10–6	4.5	37	9–0	3.3
116	18–2		96	15–0	9.0	76	12–0	6.2	56	10–5	4.4	36	8–11	3.2
115	17–11		95	14–10	8.9	75	11–11	6.1	55	10–4	4.4	35	8–10	3.2
114	17–8		94	14–8	8.7	74	11–10	6.0	54	10–3	4.3	34	8–9	3.1
113	17–6		93	14–6[2]	8.5	73	11–9	5.9	53	10–2	4.3	33	8–8	3.1
112	17–4		92	14–4	8.4	72	11–8	5.8	52	10–1	4.2	32	8–7	3.1
111	17–2		91	14–1	8.2	71	11–7	5.7	51	10–0	4.1	31	8–6	3.0
110	17–0		90	13–11	8.1	70	11–6	5.7	50	9–11	4.1	30	8–5	3.0
109	16–10		89	13–9	7.9	69	11–5	5.6	49	9–11	4.0	29	8–4	2.9
108	16–8		88	13–7	7.8	68	11–4	5.5	48	9–10	4.0	28	8–3	2.9
107	16–6		87	13–5	7.6	67	11–3	5.4	47	9–9	3.9	27	8–2	2.8
106	16–5		86	13–3	7.5	66	11–2	5.3	46	9–8	3.9	26	8–1	2.8
105	16–3		85	13–1	7.4	65	11–1	5.2	45	9–7	3.8	25	8–0	2.8
104	16–2		84	12–11	7.2	64	11–0	5.1	44	9–6	3.7	24	7–11	2.7
103	16–0		83	12–10	7.1	63	10–11	5.0	43	9–5	3.6	23	7–10	2.7
102	15–11	10.0	82	12–8	7.0	62	10–10	4.9	42	9–4	3.6	22	7–8	2.6
101	15–9	9.8	81	12–7	6.8	61	10–9	4.8	41	9–3	3.5	21	7–6	2.6
												20	7–5	2.6

[1] Grade defined as in the table in the Directions for Administering.
[2] Arithmetic ages above this point are extrapolated values.

TO THE EXAMINER. *Do not administer this test without first reading carefully the Directions for Administering.*

TEST	SCORE	ARITH. AGE	SCHOOL GRADE
Arith. Reas.			
Arith. Comp.			
Total (Average) Arith.[1]			

[1] The Total Arithmetic Score is the *average* of the scores on the two tests.

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DIRECTIONS: Find all the answers as quickly as you can. Write the answers on the dotted lines. Use the margins to figure on.

1 How many are 4 cats and 3 cats?

Answer.....

2 Mary had eight oranges and ate two. How many did she have left?

Answer.....

3 Mary has 7 yards of blue and 14 yards of pink ribbon. How many yards of ribbon has she all together?

Answer.....

4 Jack's garden has 3 rows of carrots, 9 rows of radishes, and 7 rows of peas. How many rows is this in all?

Answer.....

5 If silk thread costs 8 cents a spool, how many spools can you buy for 16 cents?

Answer.....

6 Dick was given 15 examples to work. He has already worked 9 of them. How many more has he to work?

Answer.....

7 A boy planted 3 rows of seeds, putting 8 seeds in a row. How many seeds did he plant?

Answer.....

8 Jim caught 18 fish and Jack caught half as many. How many fish did they both catch?

Answer.....

9 Bill had 8 cents and his father gave him 5 cents more. How much more does he need in order to buy a 25-cent toy?

Answer.....

10 Frank found 4 eggs in each of 6 nests. How many *dozen* eggs did he find in all?

Answer.....

11 Pearl paid 20 cents a dozen for lemons and 35 cents a dozen for oranges. She bought two dozen oranges and a dozen lemons. How much did they cost her?

Answer.....

Go right on to the next column.

12 Canned peas are priced at 20 cents a can or a dozen cans for $2. How much is saved by buying a dozen cans at that rate?

Answer.....

13 Frank bought his bicycle for $40. He sold it a year later for ¾ of its cost. What was the selling price?

Answer.....

14 A class of 18 students had a party. The cost of the refreshments was $4.50. If they divided the cost equally, how much should each pay?

Answer.....

15 Dan earned $2.75 each week. At the end of a six-weeks period he had saved $11.25. How much had he spent?

Answer.....

16 Pearl sold $46.80 worth of eggs one summer. Her mother allowed her to keep ⅛ of this amount as her own. How much money did Pearl keep?

Answer.....

17 Jenny earns $20 a week for 50 weeks in a year. Her brother gets a salary of $2,400 per year. How much per year more does the brother get than Jenny?

Answer.....

18 At the rate of 7½ miles in 15 minutes, how far will a train go in an hour?

Answer.....

19 At 4 yards for 5 cents, how many yards of trimming can be bought for 40 cents?

Answer.....

20 Sound travels at the rate of a mile in 5 seconds, and light travels a mile in so short a time as to be practically unmeasurable. If you see a flash of lightning and 10 seconds later hear the thunder, how far away was the lightning?

Answer.....

21 Muriel worked ¼ of her problems in 7 minutes. At the same rate, how many more minutes will it take her to finish?

Answer.....

Go right on to the next page.

No. Rt.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	23	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Score	3	10	17	24	31	37	42	49	55	59	62	66	69	72	76	79	82	84	86	88	91	94	97	100	103	105	106	108	109	111	112	114	116	117	119	120	122	124	125	127	129

22 Donald needs 3 pieces of rope, each 4 ft. 9 in. long. How long a piece of rope must he get from which to cut them?
Answer.....

23 A tailor sold a suit for $60, which in addition to $4 a yard for 5½ yards of cloth, cost him $20 for labor and $5 for general shop expenses. What was his profit on the suit?
Answer.....

24 Pearl's father bought enough picture molding to go around a room which is 12½ feet wide and 15 feet long. At 2 cents per foot what did it cost? (Ignore cutting wastes.)
Answer.....

25 A family having a yearly income of $2,400 proposed to spend 20 per cent of it for rent. How much per month will this allow?
Answer.....

26 The shadow of a tall building was 80 feet long when a lamp post 12 feet high cast a shadow 6 feet long. How tall is the building?
Answer.....

27 The boys of Lincoln School won 5 of the 8 games of basketball which they played. What per cent of their games did they win?
Answer.....

28 The rainfall for Portland, Oregon, for the years 1915–1918 was 31, 35, 42, and 38 inches respectively. What was the average rainfall during these years?
Answer.....

29 One month a farmer sold 2,000 lb. of milk to a creamery. The milk contained 3.5% of butter fat, for which he received 25 cents a pound. How much did he receive for the butter fat?
Answer.....

30 After 12 gallons had been taken from a can of water which was ⅝ full, it was then ⅙ full. How much water would the can hold when full?
Answer.....

31 A man offered to lay a cement walk for $72. The walk was 4 feet wide and 60 feet long. How much was he charging per square foot?
Answer.....

Go right on to the next column.

32 A man bought four horses at $180 each, less a discount of 33⅓ per cent. How much did he pay?
Answer.....

33 Allowing 20% of the selling price of the clothing for the overhead expense of the store, how many dollars net profit does a dealer make on a suit bought for $25 and sold for $40?
Answer.....

34 John can read 30 pages while Jane can read 20. How long will it take Jane to read a book that John can read in 5 hours?
Answer.....

35 A recipe for jam calls for 3 lb. of sugar to 4½ lb. of fruit. If 6 lb. of fruit are used, how much sugar is needed?
Answer.....

36 A man paying 20 cents a gallon for gasoline ran 640 miles on 40 gallons. How much per mile did the gasoline cost him?
Answer.....

37 Potatoes contain 70 per cent water, 20 per cent starch, and 10 per cent mineral matter. How many pounds of potatoes are needed to yield 200 lb. of starch?
Answer.....

38 A house sold for $3,000. Out of this was paid $20 for taxes, $25 for abstract of title, 5 per cent as a commission, and ⅕ of 1 per cent as miscellaneous charges. How much did the owner finally receive for his house?
Answer.....

39 Mr. White had, in 1925, an annual income of $4,000. As head of a family he was entitled to an exemption of $2,500 and for each of his two children an additional exemption of $400. If he paid 4% on the taxable portion of his income, what did he pay?
Answer.....

40 Mr. Jones bought 5 shares of Oriental Oil stock in June, 1923, at $90 per share (par value $100). In 1924 the dividend rate was 8%. After collecting his dividends, he sold his shares for $120 each. How many dollars had he made on his investment?
Answer.....

End of Test 1. Look over your work.

DIRECTIONS: Get the answers to these examples as quickly as you can without making mistakes. Look carefully at each example to see what you are to do.

Begin here.

(1)

$3 + 2 =$

(2) Add

2
6

(3) Add

8
3

(4) Add

19
3

(5) Subtract

10
8

(6) Subtract

13
9

(7) Add

25
6

(8) Add

24
35
42
56

(9) Subtract

55
32

(10)

$3 \times 4 =$

(11) Subtract

867
428

(12)

$3\overline{)9}$

(13) Multiply

35
2

(14)

$5 \times 0 =$

(15)

$8 \div 2 =$

(16)

$6\overline{)54}$

(17)

$9 \div 3 =$

(18) Subtract

1000
372

(19) Add

37
$16\frac{3}{4}$

(20)

$\frac{1}{5}$ of 200 =

(21)

$3\overline{)13.5}$

(22)

$\frac{7}{8} \times \frac{3}{4} =$

(23) Subtract

$\frac{1}{3}$
$\frac{1}{6}$

(24) Add

$\frac{2}{5}$
$\frac{7}{10}$

(25) Multiply

4679
68

Go right on to the next page.

(26)

$\frac{8}{9} \times \frac{1}{2} =$

(27)

Add
$\frac{3}{4}$
$\frac{5}{12}$

(28)

$\frac{3}{4} \times \frac{6}{7} =$

(29)

Add
$\frac{1}{2}$
$\frac{3}{10}$

(30)

Subtract
$\frac{7}{8}$
$\frac{3}{8}$

(31)

Add
$65\frac{3}{8}$
$146\frac{3}{8}$

(32)

Subtract
$83\frac{1}{6}$
$45\frac{1}{9}$

(33)

$\frac{7}{8} \div \frac{7}{8} =$

(34)

Add
$94\frac{1}{4}$
$20\frac{7}{9}$

(35)

Add
88.7
4.8
64.9
967.5
306.3

(36)

$\frac{7}{12} \div \frac{5}{7} =$

(37)

$\frac{2}{5} \div \frac{1}{3} =$

(38)

Multiply
4.326
315

(39)

Subtract
$\frac{1}{6}$
$\frac{1}{10}$

(40)

Multiply
7924
38

(41)

Subtract
$93\frac{2}{3}$
$57\frac{5}{6}$

(42)

Subtract
$43\frac{1}{3}$
$25\frac{1}{2}$

(43)

$2.5\overline{)12515}$

(44)

$4.4 + .00044 + 4400 + .04 =$

(45)

The marked price was $250.00. 20% discount was allowed. Find the selling price.

Selling price =

(46)

$\frac{3}{8} + \frac{5}{6} + \frac{3}{4} =$

(47)

Multiply
3648
.427

Turn the page and go right on.

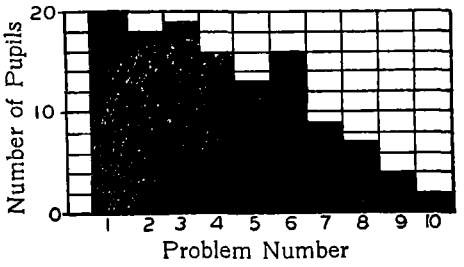
(48)

Subtract

$23\frac{7}{10}$

$18\frac{5}{6}$

(49–50)



This graph shows the number of pupils who solved each of ten problems.

(*a*) What two problems were solved by the same number of pupils? .....and.....

(*b*) How many problems were solved by less than half the pupils? .....

(51)

Find the average:

6.47
5.89
3.42
.65
7.09

(52)

$\frac{8}{9} \div 1\frac{10}{21} =$

(53)

Multiply

3 yd. 2 ft. 5 in.

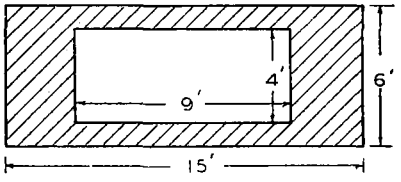
4

(54)

$(5)^4 =$

(55)

Find the area of the shaded portion of this figure:



Area =

(56)

Find the value of P in this formula when $D = 5$ and $N = 4$:

$$P = \frac{D^2 N}{25}$$

$P =$

(57)

Write the following expression in the simplest form:

$$-11b - (-2b)$$

Answer =

(58)

$\sqrt{45369}$

(59)

Factor the expression:

$$5x + 5y$$

Answer =

(60)

If $A = \frac{1}{2}ba$, write the formula for b.

$b =$

End of Test 2. Look over your work.

Number right	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Score	3	7	13	18	23	26	29	32	35	37	39	42	45	48	51	54	56	58	60	62	63	64	66	67	68	70	71	73	74	76	78

Number right	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Score	80	82	84	86	88	90	92	94	96	98	100	103	106	109	111	112	113	114	114	115	115	116	116	117	117	118	119	120	122	124

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